WHAT IS CLAIMED IS:

1. A molecule comprising a peptide which binds to a substance of interest, which peptide is identified by a method comprising:

(a) screening a first random peptide library with a first ligand, said first ligand being a specific binding partner of said substance of interest, to identify a first peptide that specifically binds to said first ligand; and

(b) screening a second random peptide library with a second ligand comprising said first peptide identified in step (a), to identify a second peptide which binds to said second ligand and which binds to said substance of interest.

2. A molecule comprising a peptide which binds to an antigen of interest, which peptide is identified by a method comprising:

(a) screening a first random peptide library with an antibody or antigen-binding derivative thereof that specifically binds to an antigen of interest, to identify a first peptide that specifically binds to said antibody or antigen-binding derivative thereof; and

(b) screening a second random peptide library with a compound comprising said first peptide identified in step (a), to identify a second peptide which binds to said compound and which binds to said antigen of interest.

3. The molecule of claim 2, in which said first random peptide library is a different library from said second random peptide library.

4. The molecule of claim 2, in which said first random peptide library is the same library as said second random peptide library.

5. The molecule of claim 1, in which said method further comprises comparing the sequences of a plurality of different first peptides identified as binding said first ligand in step (a), to identify a consensus binding sequence, in which said second ligand of step (b) comprises said consensus binding sequence.

6. The molecule of claim 2, in which said method further comprises comparing the sequences of a plurality of different first peptides identified as binding said antibody or antigen-binding derivative thereof in step (a), to identify a consensus binding sequence, in which said compound of step (b) comprises said consensus binding sequence.

7. The molecule of claim 1 in which the first ligand comprises a receptor.

8. The molecule of claim 2 in which the antibody is the monoclonal antibody 7E11-C5.

9. The molecule of claim 1 in which the library of step (a) or step (b) is a library of recombinant vectors that express a plurality of heterofunctional fusion proteins, said fusion proteins comprising a binding domain encoded by an oligonucleotide comprising unpredictable nucleotides in which the unpredictable nucleotides are arranged in one or more contiguous sequences, wherein the total number of unpredictable nucleotides is greater than or equal to about 15 and less than or equal to about 600.

10. The molecule of claim 2 in which the library of step (a) or step (b) is a library of recombinant vectors that express a plurality of heterofunctional fusion proteins, said fusion proteins comprising a binding domain encoded by an oligonucleotide comprising unpredictable nucleotides in which the unpredictable nucleotides are arranged in one or more

contiguous sequences, wherein the total number of unpredictable nucleotides is greater than or equal to about 15 and less than or equal to about 600.

11. The molecule of claim 1 in which the library of step (a) or step (b) is a chemically synthesized library.

12. A molecule comprising: an amino acid sequence selected from the group consisting of:

GIINANDPLPFWFMSPYTPGPAPIDINASRALVSNESG (SEQ ID NO: 1),
CGRAYCLSGNYNIFGALPPGVSTPYADVGHDDAQSWRR (SEQ ID NO: 3),
DLSRNLDFGRFLLYNAYVPGFTPTFISLTAEHLSSPKG (SEQ ID NO: 2),
RCSPIWGISYPFGLLSSNPGVCHSSDAETNIRNDILTT (SEQ ID NO: 4),
and
GHSNYCFVSTLGMPIVGFPSINARGLIHYGGSDPRLAA (SEQ ID NO: 5);

or a binding portion thereof.

13. A peptide in which the amino acid sequence of said peptide consists of the sequence selected from the group consisting of:

GIINANDPLPFWFMSPYTPGPAPIDINASRALVSNESG (SEQ ID NO: 1),
CGRAYCLSGNYNIFGALPPGVSTPYADVGHDDAQSWRR (SEQ ID NO: 3),
DLSRNLDFGRFLLYNAYVPGFTPTFISLTAEHLSSPKG (SEQ ID NO: 2),
RCSPIWGISYPFGLLSSNPGVCHSSDAETNIRNDILTT (SEQ ID NO: 4),
and
GHSNYCFVSTLGMPIVGFPSINARGLIHYGGSDPRLAA (SEQ ID NO: 5);

or a binding portion thereof.

14. A method of identifying a peptide which binds to a substance of interest, comprising:

(a) screening a first random peptide library with a ligand, said ligand being a specific binding partner of said substance of interest, to identify a first peptide that specifically binds to said ligand; and

(b) screening a second random peptide library with a compound comprising said first peptide identified in step (a), to identify a second peptide which binds to said

compound and which binds to said substance of interest.

Sub A26

15. A method of identifying a peptide which binds to an antigen of interest, comprising:

(a) screening a first random peptide library with an antibody or antigen-binding derivative thereof that specifically binds to an antigen of interest, to identify a first peptide that specifically binds to said antibody or antigen-binding derivative thereof; and

(b) screening a second random peptide library with a molecule comprising said first peptide identified in step (a), to identify a second peptide sequence which binds to said molecule and which binds to said antigen of interest.

Sub A27

16. The method of claim 14, in which said first random peptide library is a different library from said second random peptide library.

17. The method of claim 14, in which said first random peptide library is the same library as said second random peptide library.

18. The method of claim 14 in which the ligand is a receptor.

Sub A28

19. The method of claim 15 in which the antibody is the monoclonal antibody 7E11-C5.

20. The method of claim 14 in which the library of step (a) or step (b) is a library of recombinant vectors that express a plurality of heterofunctional fusion proteins, said fusion proteins comprising a binding domain encoded by an oligonucleotide comprising unpredictable nucleotides in which the unpredictable nucleotides are arranged in one

or more contiguous sequences, wherein the total number of unpredictable nucleotides is greater than or equal to about 15 and less than or equal to about 600.

Sub A29

21. The method of claim 15 in which the library of step (a) or step (b) is a library of recombinant vectors that express a plurality of heterofunctional fusion proteins, said fusion proteins comprising a binding domain encoded by an oligonucleotide comprising unpredictable nucleotides in which the unpredictable nucleotides are arranged in one or more contiguous sequences, wherein the total number of unpredictable nucleotides is greater than or equal to about 15 and less than or equal to about 600.

22. The method of claim 14 where the library of step (a) or step (b) is a chemically synthesized library.

Sub A30

23. A method of detecting or measuring an analyte of interest in a sample, comprising:

(a) contacting a sample with a molecule comprising a peptide capable of specifically binding said analyte of interest under conditions such that specific binding between said molecule and said analyte can occur; and

(b) detecting or measuring the amount of said binding in which the presence and amount of said binding indicates the presence and amount, respectively, of said analyte in the sample;

in which said peptide is identified by the method of claim 14.

24. The method of claim 23 in which said molecule is immobilized on a solid substratum.

25. A method of determining the location in a patient of a tumor comprising:

(a) introducing a molecule comprising a peptide that specifically binds to a tumor antigen into the patient; and

(b) determining the location in the patient of the molecule;

in which the molecule is detectably labeled; and in which said peptide is identified by a method comprising:

(i) screening a first random peptide library with an antibody or antigen-binding derivative thereof that specifically binds to said tumor antigen, to identify a first peptide that specifically binds to said antibody or antigen-binding derivative thereof; and

(ii) screening a second random peptide library with a molecule comprising said first peptide identified in (i), to identify a second peptide which binds to said molecule and which binds to said tumor antigen.

26. A therapeutic or diagnostic composition comprising the molecule of claim 1; and a pharmaceutically acceptable carrier.

27. A therapeutic or diagnostic composition comprising the molecule of claim 2; and a pharmaceutically acceptable carrier.

28. A therapeutic or diagnostic composition comprising the molecule of claim 5; and a pharmaceutically acceptable carrier.

29. A therapeutic or diagnostic composition comprising the molecule of claim 7; and a pharmaceutically acceptable carrier.

Sub A32

30. A therapeutic or diagnostic composition comprising the molecule of claim 8; and a pharmaceutically acceptable carrier.

31. A therapeutic or diagnostic composition comprising the molecule of claim 12; and a pharmaceutically acceptable carrier.

32. A composition comprising a plurality of molecules of claim 1, in which said peptide sequences of said molecules differ.

Sub A33

33. A molecule comprising a peptide or a binding portion thereof which binds to a ligand of interest, which peptide is identified by a method comprising: screening a random peptide library with a ligand of interest, said ligand of interest being a peptide having a length of between 5 and 40 amino acids, to identify a peptide that specifically binds to the ligand of interest, in which the ligand of interest is also specifically bound by an antibody or a receptor.

34. The molecule of claim 31 in which the ligand is a peptide having a length of between 10 and 20 amino acids.

Sub A34

35. A method of obtaining an image of an internal region of a subject comprising administering to said subject an effective amount of the molecule of claim 1 in which said molecule is radiolabeled with a radioactive metal, and recording the scintigraphic image obtained from the decay of said radioactive metal.

Sub A34 Cont

36. A molecule comprising a peptide which binds to a substance of interest, which peptide is identified by a method comprising: screening a random peptide library with a ligand, said ligand being a peptide of 36 amino acids or fewer, in which the ligand is an epitope of an antigen that is specifically bound by an antibody or in which the ligand represents the portion of a receptor-ligand that is responsible for the specific binding of the receptor to the receptor-ligand.

37. A peptide comprising the amino acid sequence WQGTHF (SEQ ID NO: 23) and the amino acid sequence LVSKNDSG (SEQ ID NO: 24) that specifically binds to an antigen of human prostate carcinoma cells.

38. A molecule comprising an amino acid sequence selected from the group consisting of:

SFMDYFRHTPEPKPAGYPNAYTDPKHPA (SEQ ID NO: 26),

SSSIFDYAPFSWGSAGLSNSSINVFERS (SEQ ID NO: 27),

SASLWDALGGWTTSAVPSYPRPHQTPGR (SEQ ID NO: 28),

SLGLPWIDVFGRSSAEPWPFGRTNLPRS (SEQ ID NO: 29),

SVHGAFLDSFFPWAADGPHGRGRLTSF (SEQ ID NO: 30),

EEKQGGRWSTMMPRRWCHEGGCGFLYYDAMTKPKTPPIMRTAA (SEQ ID NO: 31),

LPRPFDDASWKLRAVKESPDGCGFGSPLLFPPYSGLPTFSSCD (SEQ ID NO: 32),

GSFESARGVTCIGNHSIGAHGCGPLRSYASFNRGSGRRH (SEQ ID NO: 33),

DQIGSRPQTTSRSISGSWWENAKTLWQQDYAFSAPNAA (SEQ ID NO: 34),

LSDAWGNFTTSYRDSAGFPSHAMTTSQGGKRNHASRFP (SEQ ID NO: 35),

VQLDDTSPRASGQETSQSEYDARPLLSKFAIPRPWSR (SEQ ID NO: 36),

IDSSKNRISGTGYLSFPHIRHANRRHMADDSNLAPGPS (SEQ ID NO: 37),

WSIGTHTGPEGKFRIPCDRSGCGGTTLTHGGLNSSPTGQHERP (SEQ ID NO: 38),

DPCEDGYWLSSVGRAGASIRGCGAIRRSSRTLTAEYSTRASNH (SEQ ID NO: 39),

GSKRSCWGTTISNYFRPVPEGCGSASSINPNTNTGRLPSLHRQ (SEQ ID NO: 40),
SSASSGCLGRAEHLDLDSVWGCGSQADMSRRYSPWYGRPRTGV (SEQ ID NO: 41),
NVMWSSSKAGIRDCSQVPPGGCGPVNRHRASPPLTPFRHGSIR (SEQ ID NO: 42),
PLTSGSSSEYRNRDDCPVYKYATNCPRLNFSPSRYSPF (SEQ ID NO: 43),
GDAYGGIFSRPRQGLADSYIHASYTGKHFFRGPRPPTR (SEQ ID NO: 44),
STCIGAEGEWKSFHNFLQCRDATSTSSSTLDPTALRFG (SEQ ID NO: 45),
YSATLWDQFGSRQVELWSNRHASSALPFASRASVLGSR (SEQ ID NO: 46),
ILGWPFLTGLGDSTVHPRGRKGTDPS (SEQ ID NO: 47),
SIPSFSMWLNQLGSAALPSKGNSQDRSD (SEQ ID NO: 48),
SRDDIFTGGPLVLFRGSKTSNHDVHSMR (SEQ ID NO: 49),
RAELVNWYEWFHVTAEAETPVINSHNMT (SEQ ID NO: 50),
GAPVWRGNPRWRGPGGFKWPGCGNGPMCNTFTPARGGSRNNGP (SEQ ID NO: 51),
GSASSCFPNFTARGVTVGFFGCGSPAHPAAPRVLNPATDFPAP (SEQ ID NO: 52),
VFRRTARSSRPIGATVFPWYGCGNSNDETLPHHDSPPSFFLGA (SEQ ID NO: 53),
NTCWTDLFWHGLPGGDLPRDGCGLPSELTTHPSRERRDASEN (SEQ ID NO: 54),
IDWNWLERGQHNRGYLHSFPDAKSQPTRGPRVAPNGND (SEQ ID NO: 55) and
GRGSDMREHWPWSMPLILDQHANDPSPRAQSHYYSHPF (SEQ ID NO: 56).

39. A molecule comprising an amino acid sequence selected from the group consisting of:

VSTGWSGTPRWCAPGGKQGSSCGNGPRWTTLTPDLGGTRKYGP (SEQ ID NO: 57),
GAPLWCEKLSGTGSGGFKWPGCGSGPTYNTFTPARVGSDNKWP (SEQ ID NO: 58),
GPPVWSAKSRWTGTGVLNWPGCGKVRSCSTYTPSRDRSRKSDP (SEQ ID NO: 59),

GSALLTSKGCVRGPGGLMRPGCGNDRLGKSSTYAHGGWIKTGP (SEQ ID NO: 60),

GSPVWSGDNRWRGSSPLKRPGCGNGAKCNTLKDNRKDSRKTKH (SEQ ID NO: 61),

G PLLPGEAAVHGARGLMRSGCGNGPTWNRLTAACRDSRNKGP (SEQ ID NO: 62),

GSPVWMGSTRWTGHGWFRSQGCGNVPRTNSCAPAGKDSQNKGP (SEQ ID NO: 63),

GAPVWRGNRWCSDNGELERPGCGYGPRFNILPPGRGNSRKPSP (SEQ ID NO: 64),

GSSGWKVKHRCGGPGTLQRPGCGNLPLGHTFPPTRGGSHMEGA (SEQ ID NO: 65),

GPRSWMGQPRGSDAGSCKWAGCGDAPMWRASTPGHGGPPNRGS (SEQ ID NO: 66),

EALVCRGKPPWSGPAGLLWQGCGTGPVSRTFTSAQGRSRNKTS (SEQ ID NO: 67),

GAPVVGDILWCSGARGAKWPGCGKGPTNKTFSHSRGGTQKSGL (SEQ ID NO: 68),

GAPVSRCKPACGGFWGVNWPGCGNASMCKTFTNGHGVSSDNGH (SEQ ID NO: 69),

GAHGYKNGSTCTGLGGWRCRGCGKGAMCNNPSPAGGAYHNQGP (SEQ ID NO: 70),

G PQGSEHQCCSGHWGLKFPGCGNGPICNNFTALRGASRKNGP (SEQ ID NO: 71),

GEPVWCRHSGGRVQGGLDWLGCGDGPLRYTVTPARGGPSKHGP (SEQ ID NO: 72),

GLSLVRGDSWGSGAGGWKRHGCGHGPMYNPQTPARGGSCTRNT (SEQ ID NO: 73),

VSRAWSGKPRLMGSHGLNCPGCGKGHSGIMFIPDPAGSANTPP (SEQ ID NO: 74),

CAPMWSGKPPWCVGGGVKFRGCGNRPDCNIITPRLVESRDKAL (SEQ ID NO: 75) and

ADPVCSRKPDGGGLRGLRWPGCGKGPILYNVTAARGGSRNNGP (SEQ ID NO: 76).

40. The molecule which binds to a ligand of interest of claim 33 in which said ligand comprises VTSAPDTRPAPGSTAPPAHGVTSAPDTR (SEQ ID NO: 9) or a portion thereof.

41. A therapeutic or diagnostic composition comprising a molecule chosen from the group of molecules of claim 38 and a pharmaceutically acceptable carrier.

42. A therapeutic or diagnostic composition comprising a molecule chosen from the group of molecules of claim 39 and a pharmaceutically acceptable carrier.

43. A molecule that binds to polymorphic epithelial mucin, comprising an amino acid sequence represented by the formula:

$R_1R_2R_3R_4R_5R_6R_7R_8R_9R_9R_{10}R_{11}R_{12}R_{13}R_{14}R_{15}R_{16}R_{17}R_{18}R_{19}R_{20}R_{21}R_{22}R_{23}R_{24}R_{25}R_{26}$
$R_{27}R_{28}R_{29}R_{30}R_{31}R_{32}R_{33}R_{34}R_{35}R_{36}R_{37}R_{38}R_{39}R_{40}R_{41}R_{42}R_{43}$ (SEQ ID NO: 88)

wherein:

R_1= G, C, E, or V;

R_2= A, S, P, or L;

R_3= P, T, H, or L;

R_4= L, M, Q, G, A, or S;

R_5= W or Y;

R_6= S, C, K or T;

R_7= E, S, C, D, V, or R;

R_8= N, H, K, S, or E;

R_9= L, H, R, N, Q, T, or G;

R_{10}= W, P, R, T, or D;

R_{11}= W, C, V, L, or G;

R_{12}= S, T, M, or H;

R_{13}= G;

R_{14}= S, A, G, N, Q, or H;

R_{15}= W, H, G, A, or R;

R_{16}= G, T, E, P, V, or W;

R_{17}= V, F, W, K, or A;

R_{18}= K, Q, D, E, R, or L;

R_{19}= R, F, or S;

R_{20}= P, S, I or H;

R_{21}= G;

R_{22}= C;

R_{23}= G;

R_{24}= D, S, T, N;

R_{25}= G, D, L;
R_{26}= P or S;
R_{27}= M, S, D, I, L, or R;
R_{28}= G, W, C, L, F, Y, or T;
R_{29}= S, N, V, F, H, or R;
R_{30}= N, A, S, M, or R;
R_{31}= F, Q, P, or V;
R_{32}= S, V, I, K, A, or S;
R_{33}= P, A, N, or Y;
R_{34}= G, N, or L;
R_{35}= K, R, C, Q or L;
R_{36}= V, K, R, or A;
R_{37}= G, D, A, or E;
R_{38}= S, T, P, Y or W;
R_{39}= R, I, L, P, A or S;
R_{40}= N, K, or M;
R_{41}= S, R, T, E, Q, P, Y or H;
R_{42}= G, A, S, D, N, P, Y, or K;
R_{43}= P, H or A.

44. The molecule of claim 43 wherein:

R_1= G;
R_2= A;
R_3= P;
R_5= W;
R_6= S;
R_{10}= W;
R_{11}= W;
R_{12}= S or T;
R_{14}= S;
R_{16}= G;
R_{18}= K;
R_{19}= R;
R_{20}= P;
R_{26}= P;
R_{28}= G or W;
R_{30}= N;
R_{31}= F;
R_{33}= P;
R_{35}= K or R;

R_{37}= G;
R_{38}= S;
R_{40}= N or K;
R_{42}= G;

45. The molecule of claim 2 in which the antibody or antigen-binding derivative thereof is capable of specifically binding to a human tumor antigen.